CLAIMS

What is claimed is:

1. A filter device comprising:

a housing having a first end;

a first ring joinable to said first end wherein said first ring has a first annular anchor on an interior portion of said first ring;

a first flange cap joinable to said first ring forming a first seal;

a plurality of microfibers extending from said first ring through said housing, and

a first potting material encasing said plurality of microfibers at said first ring and encasing said first annular anchor forming a second seal.

2. The filter device according to claim 1 further comprising:

a second end of said housing opposite said first end;

a second ring joinable to said second end wherein said second ring has a second annular anchor on an interior portion of said second ring;

a second flange cap joinable to said second ring forming a third seal;

a second potting material encasing said plurality of microfibers at said second ring and encasing said second annular anchor forming a fourth seal.

3. The filter device according to claim 1 further comprising:

a first fluid inlet port through said first flange cap;

a first fluid outlet port through said second flange cap, wherein a first fluid pathway is defined by said first fluid inlet port, said plurality of microfibers, and said first fluid outlet port;

a second fluid inlet port through said housing and proximate to said first end; and

a second fluid outlet port through said housing and proximate to said second end, wherein a second fluid pathway is defined by said second fluid inlet port, a space between said plurality of microfibers, and said second fluid outlet port.

4. The filter device according to claim 1 wherein each of said plurality of microfibers are hollow and semipermeable.

5. The filter device according to claim 1 wherein said first annular anchor and said second annular anchor receive a surface treatment, wherein said surface treatment modifies a surface energy of said first annular anchor and said second annular anchor.

6. The filter device according to claim 5 further comprising:

a first plurality of rounded ridges on an upper surface of said first annular anchor and a second plurality of rounded ridges on a lower surface of said first annular anchor; and

a third plurality of rounded ridges on an upper surface of said second annular anchor and a fourth plurality of rounded ridges on a lower surface of said second annular anchor;

wherein said first and second plurality of rounded ridges and said third and fourth plurality of rounded ridges on said first and second annular anchors minimize a delamination of said first and second potting materials from said first and second annular anchors, and increases a surface area of said first and second annular anchors treatable through said surface treatment.

7. The filter device according to claim 6 further comprising:

a first plurality of radial channels perpendicular to said first plurality of rounded ridges on said upper surface of said first annular anchor; and

a second plurality of radial channels perpendicular to said third plurality of rounded ridges on said upper surface of said second annular anchor;

wherein said first and second plurality of radial channels allow air to escape when said first and second potting material is applied to said filter device.

8. The filter device according to claim 1 wherein said first ring is spin welded to said first end, said second ring is spin welded to said second end, said first flange cap is spin welded to said first ring, and said second flange cap is spin welded to said second ring.

9. The filter device according to claim 8 further comprising:

a first plurality of nubs on an outer portion of said first ring; and

a second plurality of nubs on an outer portion of said second ring;

wherein said fist and second plurality of nubs assist in said spin welding.

10. The filter device according to claim 8 further comprising:

at least one annular channel located between said first ring and said first end; and

at least one annular channel located between said second ring and said second end;

wherein each of said at least one annular channel accommodates a flow of flash material during said spin welding.

11. The filter device according to claim 8 further comprising:

at least one annular channel located between said first ring and said first flange cap; and

at least one annular channel located between said second ring and said second flange cap;

wherein each of said at least one annular channel accommodates a flow of flash material during said spin welding.

12. The filter device according to claim 1 wherein said first ring is laser welded to said first end, said second ring is laser welded to said second end, said first flange cap is laser welded to said first ring, and said second flange cap is laser welded to said second ring.

13. The filter device according to claim 1 wherein said housing is cylindrical in shape.

14. A filter device comprising:

a housing having a first end;

a first ring joinable to said first end wherein said first ring has a first annular anchor on an interior portion of said first ring;

a first flange cap joinable to said first ring forming a first seal;

a plurality of microfibers extending from said first ring through said housing;

a first potting material encasing said plurality of microfibers at said first ring and encasing said first annular anchor forming a second seal;

a first fluid inlet port through said first flange cap wherein a first portion of a first fluid pathway is defined by said first fluid inlet port and said plurality of microfibers; and

a second fluid inlet port through said housing and proximate to said first end wherein a first portion of a second fluid pathway is defined by said second fluid inlet port and a space between said plurality of microfibers.

15. The filter device according to claim 14 further comprising:

a second end of said housing opposite said first end;

a second ring joinable to said second end wherein said second ring has a second annular anchor on an interior portion of said second ring;

a second flange cap joinable to said second ring forming a third seal;

a second potting material encasing said plurality of microfibers at said second ring and encasing said second annular anchor forming a fourth seal;

a first fluid outlet port through said second flange cap wherein a second portion of said first fluid pathway is defined by said second fluid outlet port and said plurality of microfibers; and

a second fluid outlet port through said housing and proximate to said second end wherein a second portion of said second fluid pathway is defined by said second fluid outlet port and said space between said plurality of microfibers.

16. The filter device according to claim 14 wherein each of said plurality of microfibers are hollow and semipermeable.

17. The filter device according to claim 14 wherein said first annular anchor and said second annular anchor receive a surface treatment, wherein said surface treatment modifies a surface energy of said first annular anchor and said second annular anchor.

18. The filter device according to claim 17 further comprising:

a first plurality of rounded ridges on an upper surface of said first annular anchor and a second plurality of rounded ridges on a lower surface of said first annular anchor; and

a third plurality of rounded ridges on an upper surface of said second annular anchor and a fourth plurality of rounded ridges on a lower surface of said second annular anchor;

wherein said first and second plurality of rounded ridges and said third and fourth plurality of rounded ridges on said first and second annular anchors minimize a delamination of said first and second potting materials from said first and second annular anchors, and increases a surface area of said first and second annular anchors treatable through said surface treatment.

19. The filter device according to claim 18 further comprising:

a first plurality of radial channels perpendicular to said first plurality of rounded ridges on said upper surface of said first annular anchor; and

a second plurality of radial channels perpendicular to said third plurality of rounded ridges on said upper surface of said second annular anchor;

wherein said first and second plurality of radial channels allow air to escape when said first and second potting material is applied to said filter device.

20. The filter device according to claim 14 wherein said first ring is spin welded to said first end, said second ring is spin welded to said second end, said first flange cap is spin welded to said first ring, and said second flange cap is spin welded to said second ring.

21. The filter device according to claim 20 further comprising:

a first plurality of nubs on an outer portion of said first ring; and

a second plurality of nubs on an outer portion of said second ring;

wherein said fist and second plurality of nubs assist in said spin welding.

22. The filter device according to claim 20 further comprising:

at least one annular channel located between said first ring and said first end; and

at least one annular channel located between said second ring and said second end;

wherein each of said at least one annular channel accommodates a flow of flash material during said spin welding.

23. The filter device according to claim 20 further comprising:

at least one annular channel located between said first ring and said first flange cap; and

at least one annular channel located between said second ring and said second flange cap;

wherein each of said at least one annular channel accommodates a flow of flash material during said spin welding.

24. The filter device according to claim 14 wherein said first ring is laser welded to said first end, said second ring is laser welded to said second end, said first flange cap is laser welded to said first ring, and said second flange cap is laser welded to said second ring.

25. The filter device according to claim 14 wherein said housing is cylindrical in shape.

26. A filter device prepared by a process comprising the steps of:

(a) joining a first ring to a first end of a housing wherein said first ring has a first annular anchor on an interior portion of said first ring;

(b) inserting a plurality of microfibers within said housing that extend to said first ring;

(c) encasing said plurality of microfibers and said first annular anchor at said first ring with a first potting material forming a first seal; and

(d) joining a first flange cap to said first ring forming a second seal.

27. A filter device prepared by a process according to claim 26 wherein said encasing step (c) further comprises the steps (c1) through (c6):

(c1) attaching a first potting cap to said first ring to close off said first end;

(c2) placing said housing in a centrifuge to allow rotation about an axis of rotation perpendicular to a longitudinal axis of said housing, wherein said axis of rotation extends through a midpoint of said housing;

(c3) injecting said first potting material into said housing proximate to said first end;

(c4) spinning said housing in said centrifuge causing said first potting material to set and harden, encasing said plurality

of microfibers and said first annular anchor at said first ring at said first end forming said first seal;

(c5) removing said first potting cap; and

(c6) cutting said first potting material and said plurality of microfibers at said first end through a first plane perpendicular to said longitudinal axis, exposing an interior channel of each of said plurality of microfibers at said first end.

28. A filter device prepared by a process according to claim 26 further comprising the steps of:

(e) joining a second ring to a second end of said housing wherein said second ring has a second annular anchor on an interior portion of said second ring;

(f) extending said plurality of microfibers within said housing to said second ring;

(g) encasing said plurality of microfibers and said second annular anchor at said second ring with a second potting material forming a third seal; and

(h) joining a second flange cap to said second ring forming a fourth seal.

29. A filter device prepared by a process according to claim 28 wherein said encasing step (g) further comprises the steps (g1) through (g6):

(g1) attaching a second potting cap to said second ring to close off said second end;

(g2) placing said housing in said centrifuge to allow rotation about said axis of rotation perpendicular to said longitudinal axis of said housing, wherein said axis of rotation extends through said midpoint of said housing;

(g3) injecting said second potting material into said housing proximate to said second end;

(g4) spinning said housing in said centrifuge causing said second potting material to set and harden, encasing said plurality of microfibers and said second annular anchor at said second ring at said second end of said housing forming said third seal;

(g5) removing said second potting cap; and

(g6) cutting said second potting material and said plurality of microfibers at said second end through a second plane perpendicular to said longitudinal axis, exposing said interior channel of each of said plurality of microfibers at said second end.

30. A filter device prepared by a process according to claim 28 wherein said joining steps (a), (d), (e), and (h) further comprise the steps (a1), (d1), (e1), and (h1):

(a1) spin welding said first ring to said first end;

(d1) spin welding said second ring to said second end;

(e1) spin welding said first flange cap to said first ring; and

(h1) spin welding said second flange cap to said second ring.

31. A filter device prepared by a process according to claim 30 further comprising:

forming a first plurality of nubs on an outer portion of said first ring; and

forming a second plurality of nubs on an outer portion of said second ring;

wherein said fist and second plurality of nubs assist in said spin welding.

32. A filter device prepared by a process according to claim 30 further comprising:

forming at least one annular channel between said first ring and said first end; and

forming at least one annular channel between said second ring and said second end;

wherein each of said at least one annular channel accommodates a flow of flash material during said spin welding.

33. A filter device prepared by a process according to claim 30 further comprising:

forming at least one annular channel between said first ring and said first flange cap; and

forming at least one annular channel between said second ring and said second flange cap;

wherein each of said at least one annular channel accommodates a flow of flash material during said spin welding.

34. A filter device prepared by a process according to claim 28 wherein said joining steps (a), (d), (e), and (h) further comprise the steps (a1), (d1), (e1), and (h1):

(a1) laser welding said first ring to said first end;

(d1) laser welding said second ring to said second end;

(e1) laser welding said first flange cap to said first ring; and

(h1) laser welding said second flange cap to said second ring.

35. A filter device prepared by a process according to claim 26 further comprising:

forming a first fluid inlet port in said first flange cap;

forming a first fluid outlet port in said second flange cap;

forming a second fluid inlet port through said housing and proximate to said first end; and

forming a second fluid outlet port through said housing and proximate to said second end;

wherein a first fluid pathway is defined by said first fluid inlet port, said plurality of microfibers, and said first fluid outlet port; and

further wherein a second fluid pathway is defined by said second fluid inlet port, a space between said plurality of microfibers, and said second fluid outlet port.

36. A filter device prepared by a process according to claim 26 further comprising:

treating said first annular anchor and said second annular anchor with a surface treatment, wherein said surface treatment modifies a surface energy of said first annular anchor and said second annular anchor.

37. A filter device prepared by a process according to claim 36 further comprising:

forming a first plurality of rounded ridges on an upper surface of said first annular anchor;

forming a second plurality of rounded ridges on a lower surface of said first annular anchor;

forming a third plurality of rounded ridges on an upper surface of said second annular anchor; and

forming a fourth plurality of rounded ridges on a lower surface of said second annular anchor;

wherein said first and second plurality of rounded ridges and said third and fourth plurality of rounded ridges on said

first and second annular anchors minimize a delamination of said first and second potting materials from said first and second annular anchors, and increases a surface area of said first and second annular anchors treatable through said surface treatment.

38. A filter device prepared by a process according to claim 37 further comprising:

notching a first plurality of radial channels perpendicular to said first plurality of rounded ridges on said upper surface of said first annular anchor; and

notching a second plurality of radial channels perpendicular to said third plurality of rounded ridges on said upper surface of said second annular anchor;

wherein said first and second plurality of radial channels allow air to escape when said first and second potting material is applied to said filter device.

38. A filtering method comprising the steps of:

(a) providing a filter device having a first ring joinable to a first end of a housing wherein said first ring has a first annular anchor on an interior portion of said first ring, a plurality of microfibers within said housing that extend to said first ring, a first potting material encasing said plurality of microfibers and said first annular anchor at said first ring forming a first seal, a first flange cap joinable to said first ring forming a second seal, a second ring joinable to a second end of said housing wherein said second ring has a second annular anchor on an interior portion of said second ring, a second potting material encasing said plurality of microfibers and said second annular anchor at said second ring forming a third seal, and a second flange cap joinable to said second ring forming a fourth seal;

(b) flowing a first fluid through a first flow path defined by a first fluid inlet port in said first flange cap, through said plurality of microfibers, and flowing out of a first fluid outlet port in said second flange cap; and

(c) flowing a second fluid through a second flow path defined by a second fluid inlet port through said housing and proximate to said first end, through a space between said plurality of microfibers, and flowing out of a second fluid outlet port through said housing and proximate to said second end.

40. A filtering method according to claim 39 wherein said first annular anchor and said second annular anchor are treated with a surface treatment, wherein said surface treatment modifies a surface energy of said first annular anchor and said second annular anchor.

41. A filtering method according to claim 40 wherein said first annular anchor has a first plurality of rounded ridges on an upper surface and a second plurality of rounded ridges on a lower surface, and said second annular anchor has a third plurality of rounded ridges on an upper surface and a fourth plurality of rounded ridges on a lower surface;

wherein said first and second plurality of rounded ridges and said third and fourth plurality of rounded ridges on said first and second annular anchors minimize a delamination of said first and second potting materials from said first and second annular anchors, and increases a surface area of said first and second annular anchors treatable through said surface treatment.

42. A filtering method according to claim 41 wherein a first plurality of radial channels are notched perpendicular to said first plurality of rounded ridges on said upper surface of said first annular anchor, and a second plurality of radial channels are notched perpendicular to said third plurality of rounded ridges on said upper surface of said second annular anchor;

wherein said first and second plurality of radial channels allow air to escape when said first and second potting material is applied to said filter device.

43. A filtering method according to claim 39 wherein said first fluid flowing in said first flow path flows in a countercurrent direction to said second fluid flowing in said second flow path.

44. A filtering method according to claim 39 wherein said first fluid is blood and said second fluid is dialysate and further comprising the steps of:

connecting an arterial blood line to said first fluid inlet port;

connecting a venous blood line to said first fluid outlet port;

connecting a dialysate supply line to said second fluid inlet port;

connecting a dialysate return line to said second fluid outlet port;

wherein impurities in said blood diffuse through said plurality of microfibers into said dialysate, and further wherein nutrients diffuse through said plurality of microfibers into said blood.

45. A filter device comprising:

a housing having a first end;

a first ring joinable to said first end wherein said first ring has a first annular anchor on an interior portion of said first ring, and further wherein said first annular anchor receives a surface treatment, wherein said surface treatment modifies a surface energy of said first annular anchor;

a first flange cap joinable to said first ring forming a first seal;

a plurality of microfibers extending from said first ring through said housing, and

a first potting material encasing said plurality of microfibers at said first ring and encasing said first annular anchor forming a second seal.

46. The filter device according to claim 45 further comprising:

a second end of said housing opposite said first end;

a second ring joinable to said second end wherein said second ring has a second annular anchor on an interior portion of said second ring, and further wherein said second annular anchor receives said surface treatment, wherein said surface treatment modifies a surface energy of said second annular anchor;

a second flange cap joinable to said second ring forming a third seal; and

a second potting material encasing said plurality of microfibers at said second ring and encasing said second annular anchor forming a fourth seal.

47. The filter device according to claim 46 further comprising:

a first fluid inlet port through said first flange cap;

a first fluid outlet port through said second flange cap, wherein a first fluid pathway is defined by said first fluid inlet port, said plurality of microfibers, and said first fluid outlet port;

a second fluid inlet port through said housing and proximate to said first end; and

a second fluid outlet port through said housing and proximate to said second end, wherein a second fluid pathway is defined by said second fluid inlet port, a space between said plurality of microfibers, and said second fluid outlet port.

48. The filter device according to claim 46 further comprising:

a first plurality of rounded ridges on an upper surface of said first annular anchor and a second plurality of rounded ridges on a lower surface of said first annular anchor; and

a third plurality of rounded ridges on an upper surface of said second annular anchor and a fourth plurality of rounded ridges on a lower surface of said second annular anchor;

wherein said first and second plurality of rounded ridges and said third and fourth plurality of rounded ridges on said first and second annular anchors minimize a delamination of said first and second potting materials from said first and second annular anchors, and increases a surface area of said first and second annular anchors treatable through said surface treatment.

49. The filter device according to claim 48 further comprising:

a first plurality of radial channels perpendicular to said first plurality of rounded ridges on said upper surface of said first annular anchor; and

a second plurality of radial channels perpendicular to said third plurality of rounded ridges on said upper surface of said second annular anchor;

wherein said first and second plurality of radial channels allow air to escape when said first and second potting material is applied to said filter device.

50. A filter device comprising:

a housing having a first end;

a first ring joinable to said first end wherein said first ring has a first annular anchor on an interior portion of said first ring;

a first plurality of rounded ridges on an upper surface of said first annular anchor and a second plurality of rounded ridges on a lower surface of said first annular anchor;

a first flange cap joinable to said first ring forming a first seal;

a plurality of microfibers extending from said first ring through said housing; and

a first potting material encasing said plurality of microfibers at said first ring, and encasing said first plurality of rounded ridges on said upper surface and said second plurality of rounded ridges on said lower surface of said first annular anchor, forming a second seal;

wherein said first and second plurality of rounded ridges on said first annular anchor minimizes a delamination of said first potting material from said first annular anchor.

51. The filter device according to claim 50 further comprising:

a second end of said housing opposite said first end;

a second ring joinable to said second end wherein said second ring has a second annular anchor on an interior portion of said second ring;

a third plurality of rounded ridges on an upper surface of said second annular anchor and a fourth plurality of rounded ridges on a lower surface of said second annular anchor;

a second flange cap joinable to said second ring forming a third seal; and

a second potting material encasing said plurality of microfibers at said second ring, and encasing said third plurality of rounded ridges on said upper surface and said fourth plurality of rounded ridges on said lower surface of said second annular anchor, forming a fourth seal;

wherein said third and fourth plurality of rounded ridges on said second annular anchor minimizes a delamination of said second potting material from said second annular anchor.

52. The filter device according to claim 51 further comprising:

a first fluid inlet port through said first flange cap;

a first fluid outlet port through said second flange cap, wherein a first fluid pathway is defined by said first fluid inlet port, said plurality of microfibers, and said first fluid outlet port;

a second fluid inlet port through said housing and proximate to said first end; and

a second fluid outlet port through said housing and proximate to said second end, wherein a second fluid pathway is defined by said second fluid inlet port, a space between said plurality of microfibers, and said second fluid outlet port.

53. The filter device according to claim 51 further comprising:

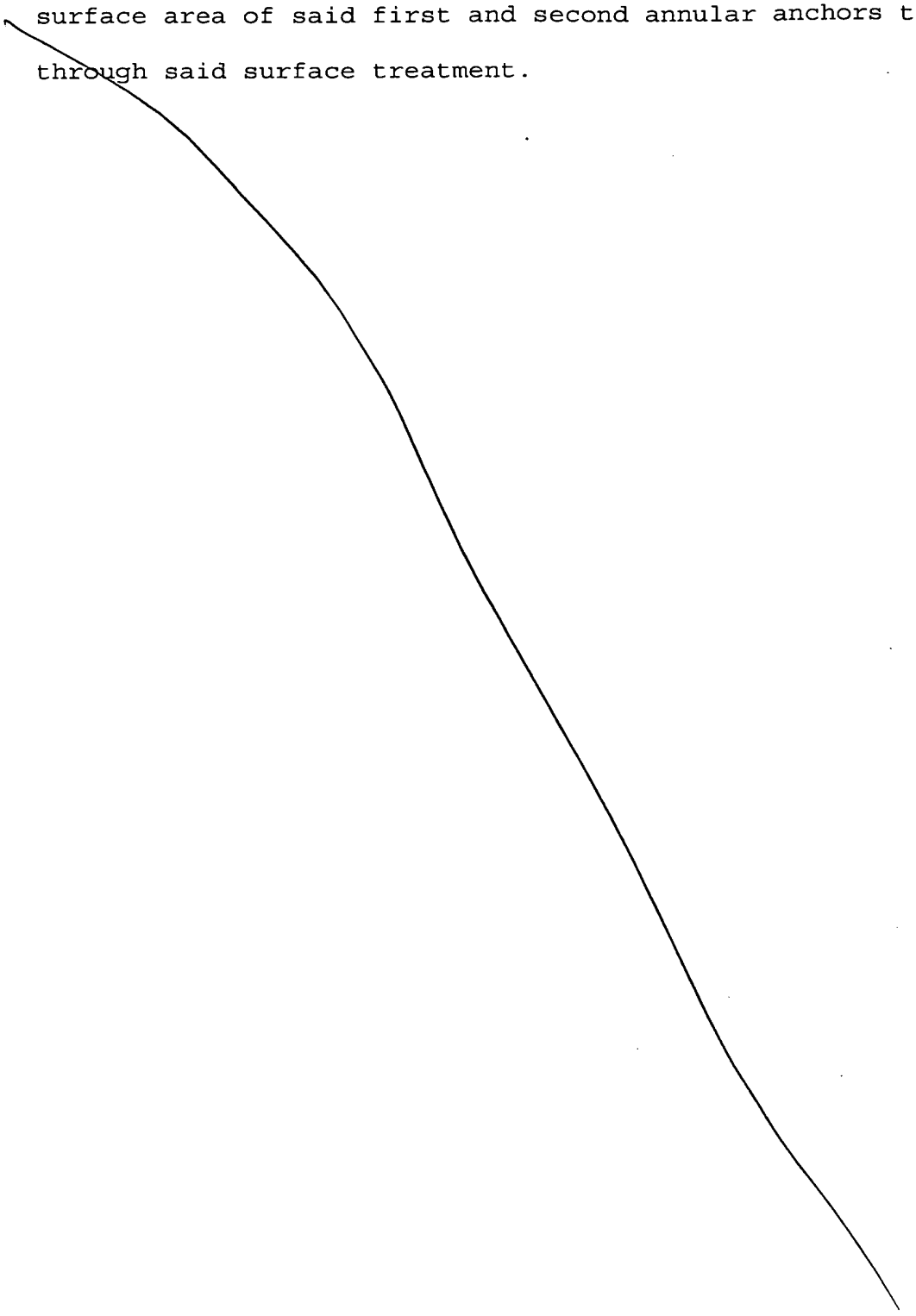
a first plurality of radial channels perpendicular to said first plurality of rounded ridges on said upper surface of said first annular anchor; and

a second plurality of radial channels perpendicular to said third plurality of rounded ridges on said upper surface of said second annular anchor;

wherein said first and second plurality of radial channels allow air to escape when said first and second potting material is applied to said filter device.

54. The filter device according to claim 51 wherein said first annular anchor and said second annular anchor receive a surface treatment, wherein said surface treatment modifies a surface energy of said first and second plurality of rounded ridges on said first annular anchor and said third and fourth plurality of rounded ridges on said second annular anchor, and further wherein said first and second plurality of rounded ridges and said third and fourth plurality of rounded ridges increases a

surface area of said first and second annular anchors treatable through said surface treatment.



55. A filter device comprising:

a housing having a first end;

a first ring joinable to said first end wherein said first ring has a first annular anchor on an interior portion of said first ring;

a first flange cap joinable to said first ring forming a first seal;

a plurality of microfibers extending from said first ring through said housing; and

a first potting material encasing said plurality of microfibers at said first ring and encasing said first annular anchor forming a second seal; and

at least one annular channel located between said first ring and said first flange cap;

wherein each of said at least one annular channel accommodates a residue material during said joining of said first flange cap to said first ring.

56. The filter device according to claim 55 further comprising:

a second end of said housing opposite said first end;

a second ring joinable to said second end wherein said second ring has a second annular anchor on an interior portion of said second ring;

a second flange cap joinable to said second ring forming a third seal;

a second potting material encasing said plurality of microfibers at said second ring and encasing said second annular anchor forming a fourth seal; and

at least one annular channel located between said second ring and said second flange cap;

wherein each of said at least one annular channel accommodates a residue material during said joining of said second flange cap to said second ring.

57. The filter device according to claim 56 further comprising:

a first fluid inlet port through said first flange cap;

a first fluid outlet port through said second flange cap, wherein a first fluid pathway is defined by said first fluid inlet port, said plurality of microfibers, and said first fluid outlet port;

a second fluid inlet port through said housing and proximate to said first end; and

a second fluid outlet port through said housing and proximate to said second end, wherein a second fluid pathway is defined by said second fluid inlet port, a space between said plurality of microfibers, and said second fluid outlet port.

58. The filter device according to claim 56 further comprising:

at least one annular channel located between said first ring and said first end; and

at least one annular channel located between said second ring and said second end;

wherein each of said at least one annular channel accommodates a residue material during said joining of said second ring to said second end.

59. The filter device according to claim 56 wherein said first annular anchor and said second annular anchor receive a surface treatment, wherein said surface treatment modifies a surface energy of said first and second annular anchors.

60. The filter device according to claim 59 further comprising:

a first plurality of rounded ridges on an upper surface of said first annular anchor and a second plurality of rounded ridges on a lower surface of said first annular anchor; and

a third plurality of rounded ridges on an upper surface of said second annular anchor and a fourth plurality of rounded ridges on a lower surface of said second annular anchor;

wherein said first and second plurality of rounded ridges and said third and fourth plurality of rounded ridges on said first and second annular anchors minimize a delamination of said first and second potting materials from said first and second

annular anchors, and increases a surface area of said first and second annular anchors treatable through said surface treatment.

61. The filter device according to claim 56 further comprising:

a first plurality of radial channels perpendicular to said first plurality of rounded ridges on said upper surface of said first annular anchor; and

a second plurality of radial channels perpendicular to said third plurality of rounded ridges on said upper surface of said second annular anchor;

wherein said first and second plurality of radial channels allow air to escape when said first and second potting material is applied to said filter device.